Effect of Weak Discreteness on Two-Soliton Collisions in Nonlinear Schrödinger Equation

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The fully integrable nonlinear Schrödinger equation (NLSE) supports the solutions in the form of solitons colliding purely elastically, i.e., without momentum and energy exchange. In many physical applications, one has to introduce into NLSE some (usually small) perturbation terms. For example, in nonlinear optics, many important effects are described by saturation, quintic and other terms [1, 2]. In physics of discrete lattices, natural and synthetic biomolecules, the effects of discreteness cannot be neglected. The discrete version of NLSE describes the phenomena of self-trapping of vibrational modes in various discrete physical systems. The effects of different perturbations have been well studied. Perturbations break down the integrability of the system, soliton collisions become inelastic and usually they are accompanied by a significant radiation. However, recently a nontrivial effect of perturbation that is a *radiationless* energy exchange between three colliding solitons has been reported for perturbed NLSE [3] and sine-Gordon [4] equations. Authors of Ref.[3] have not found similar effect for the two-soliton collisions.

In the present work, we demonstrate that a strong radiationless energy exchange can be observed in *two-soliton* collision. We predict the possibility of *strongly* inelastic collision in a *weakly* discrete system from the analysis of the two-soliton solution [5] to the unperturbed NLSE and confirm the prediction numerically. The condition of strongly inelastic collision is given. Since the effect can be understood from the integrable limit, it appears to be qualitatively independent on the particular type of perturbation. The conditions of mutual trapping of the two colliding solitons almost without radiation losses are analyzed as well.

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